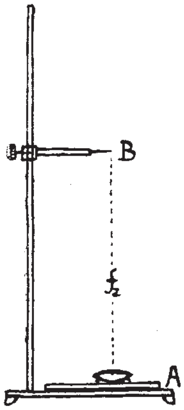
is a variation of very long period or a secular change we must in the next few years experience a preponderance of summers with more than the average number of "hot" days.
E. GOLD.

Hampstead Garden Suburb, N.W., October 23.

Determination of Refractive Index of a Liquid.

THE following simple method of finding the refractive index of a liquid available in small quantities may be of interest.

A plane mirror A is placed on the base of the stand, and on it is put the double convex lens in such a position that its centre is beneath the needle point B. With the eye directly above B, the observer adjusts the sliding arm until the needle point and its image just coincide, as found by parallax. The distance from B to the centre of the lens is then accurately found—let it be f_1. The experiment is then repeated, after first placing a drop of the liquid upon the mirror, when it will be spread out to a plano-convex lens between the glass lens and the mirror—let the new focal distance be f_2; then evidently the focal length f of the liquid lens will be given by $1/f=1/f_2-1/f_1$.



But since the focal length of the liquid lens is also given by the relation $1/f=(\mu-1)/r$, where r is the radius of curvature of the surface of the glass lens, it is evident that from a knowledge of r the index of refraction of the liquid can be at once found.

If r is not known it can be found by putting a sheet of paper between the lens and mirror, and again obtaining an image of B coincident with itself by reflection in the lower surface of the lens. If this new distance from the lens be called d, we have, since reflection is now only at the upper surface of the lens, $\mu/r-1/d=(\mu-1)/-r$, or $r=(2\mu-1)d$, where μ now, of course, refers to the glass, and can, if necessary, be calculated.

The apparatus is thus complete in itself, and three readings of the position of B give all the data required.
G. N. PINGRIFF.

Market Bosworth Grammar School.

The Nematodes of the Thames.

IN a recent letter to NATURE on the "Ooze of the Thames," I alluded to the number of nematodes which I had observed. I found as I continued my researches at least three different species were present. I have since been working on some ooze from near the Tower Bridge, and again find three different species, some of which are quite distinct from the forms taken at Kew. Thus the two localities yield at least four, if not five, different kinds. They range from about 3 mm. to 20 mm. or more in length. Considering the important part which some of these lowly creatures play in human and animal pathology, it would seem that the Thames mud offers a wide field for investigation. May we hope that this note will direct the attention of London naturalists to a subject of great importance lying close to hand?

Swadlincote. HILDERIC FRIEND.

Miniature Rainbows.

WITH reference to the recent correspondence on miniature rainbows, there is, or was, a most perfect example at the beautiful waterfall known as "Stock Gill Force," situate half a mile outside the little town of Ambleside, near the head of Lake Windermere, County Westmorland.

About five o'clock in the evening is the best time to see it, and, of course, the sun must be shining.
RICHD. COULSON.

4 Waltham Terrace, Blackrock, Co. Dublin,
October 15.

Olive Trees.

IN this part of the world when an olive plantation is being made trees of more than 6 inches in diameter in the stem are put in, with all roots cut off short. In the hole where they are planted about two handfuls of barley are also put in.

Considering the age of the trees and the way the roots are cut away, it would seem impossible that the tree would ever grow.

These facts may be of interest; and I should like to know what useful purpose is served by the barley.

Smyrna, Asia Minor. DORA BARFIELD.

EXPLOSIVES ON BOARD BATTLESHIPS.

SOME people have been tempted of late to look back to the old days when black powder held its sway, indifferent to the effects of temperature, and always to be trusted so long as it was kept dry. "Villainous saltpetre" it was called, with a rough affection, and after storing it on shore in magazines plumed with lightning conductors, or comfortably near the boilers on board ship, we never gave it a thought until it was fed, in its flannel bag, into the gun. Then came armour and the long and hard contested duel between protection and penetration. The velocity of the projectile had to be increased. The old black powder, treat it as we would, could only deliver its rather clumsy blow which, while it imparted but a low velocity to the shell, gave an unpleasant, percussive strain to the gun. It was a push that these heavier projectiles required, not a blow.

This state of things led to the introduction of slow-burning powders, and they progressed very slowly. First, the size of grain of black powder was increased until it attained the dimensions of a two-inch cube. The improvement, however, was slight, and the internal stresses on the bore of the gun were still too great. The next step towards real progress was the introduction of what was known as cocoa, or brown powder, in which materials other than dogwood or alder furnished the carbon. This had but a short reign, its place being taken by various propellants which were frankly chemical compounds. To give a list of all this class of propellant, with which experiments and lengthy trials have been carried out with more or less success, would be far beyond the scope of this article; but the interest of the scientific world gradually focussed itself on compounds having nitro-cellulose as their chief constituent, especially after the wonderful discovery that two high explosives, gun-cotton and nitroglycerine, when chemically compounded, tamed and restrained each other, so that a propellant resulted of which the speed of burning could be regulated at will by increasing or diminishing the size of the grain or cord, and also by adjusting the proportions of its constituents. Thus came to man's hand a propellant which far outstripped black powder even in its improved forms, and threw into shade the cocoa powder which, after all, remained in the category to which the French artillerists contemptuously alluded as *poudre brutale*.

"Now," triumphantly exclaimed the gunmakers, "here is a propellant which will enable us to increase the striking velocity of our armour-piercing projectiles, and also to flatten our trajectories to an extent never before contemplated. The cemented steel plates will no longer confer invulnerability on the battleship, and our chances of hitting her will be vastly enhanced." So, to suit the new powders, guns were lengthened and charges increased, and the muzzle velocities rose by leaps and bounds, while the destructive stresses on chamber and bore were minimised by the employment of a propellant the characteristics

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of which may be summed up in the one word "suitable." Every nation adopted a powder in which nitrocellulose played the leading part, the variants being the proportions of nitroglycerine and the quantities and qualities of additional restrainers.

For a time all went well; but we, as a nation, were pointed at as being behind the times because our cordite, since it contained rather a large proportion of nitroglycerine, developed more heat, and produced more bore-erosion than powders of what had become practically pure nitrocellulose. But soon a cloud, no bigger than a man's hand, appeared above the horizon, and it was found that this class of propellant exhibited an almost sentient dislike to extremes of temperature. Not being a mechanical mixture, like the old black powder, it proclaimed itself a chemical compound with a marked tendency to instability, in a somewhat disconcerting manner. Great heat disorganised it altogether; extreme cold brought the nitroglycerine, if there were any used in the manufacture, to the surface, and this did not add to the gunner's confidence in it. The tendency to deterioration from exposure to undue heat, however, was seen to be the more to be feared of the two, and it was a drawback with which it was exceedingly difficult to deal. So far as cordite was concerned, it was found to remain stable at temperatures under 80° Fahr., but in some of the older ships, owing to steam pipes being led near, and even in some cases through, the magazines, temperatures as high as 140° were recorded, and these were equalled by those in limber boxes in some stations in India.

To keep a check on this deterioration the heat test, invented by the late Sir Frederick Abel, has always been used in this country and in the Colonies, and to its frequent application is most certainly due our immunity from explosions on board battleships. One is almost tempted to write *unberufen* before stating that we are exceptional among the larger navies in having *not* lost a ship by the explosion of its own powder. We have had our warning and have profited by it. Some ten years ago a cordite cartridge ignited on board one of our battleships, but did not fire those around it. Up to 1906, when spontaneous ignition of cordite took place with what might have been disastrous results at Haiderabad and Ferozepore, cordite, with the exception of the one cartridge mentioned above, had not given rise to an accident in thirteen years. Catastrophes were averted at both these places by conspicuous acts of daring on the part of officers and men, in the first-named by drenching boxes of cordite set smouldering by one in which the cartridges had fired, and in the other by the removal of nine tons of black powder from a burning magazine within a few feet of which were stored 135 tons of black powder.

There is now little doubt that the destruction of the United States ship, the *Maine*, was due to the spontaneous explosion of her own defective powder, and also of other ships which have since been similarly lost; the Japanese have lost two, the French two (including the *Liberté*), and the Brazilians one ship. About four years ago we began to set our house in order by installing cooling apparatus in the vicinity of the magazines, by which the temperature is kept below 80° Fahr., and the ventilation system gives the charges what may be described as an atmospheric washing, as the surrounding air is being constantly cooled and changed. Great care is taken, moreover, in the construction of our ships to protect the magazines from heat given off from boilers and steam pipes. It is natural that both magazines and boilers should be placed below the water-line, and in the least vulnerable part of the ship, and that, therefore, they should find themselves fairly close together; but a good thickness of insulating material can be interposed, and the lagging of steam pipes, purposely added to ensure the retention of heat, much diminishes radiation in their vicinity. Such precautions as these serve to reduce risk of spontaneous ignition to a minimum, and they are well worth the initial cost; but alone they are insufficient, and to them must be added periodical examinations of the propellant, the heat test being then the detective.

It would appear that gelatinised nitrocellulose is liable to be attacked by an organism which rapidly brings about its deterioration, and that nitroglycerine acts to a certain extent as an antiseptic. Another theory is that the nitroglycerine hardens the substance, and renders it less susceptible to climatic influences. The net result, however, is that pure nitrocellulose is undoubtedly less stable than nitroglycerine compounds such as cordite, and that the measure of immunity of the latter from effects of extremes of temperature varies directly with the proportion of nitroglycerine. The main difficulty, therefore, with which the authorities have to contend is the natural leaning towards a propellant which will be proof against baneful climatic influences, even though it may have a greater erosive effect on the gun. For naval services these considerations have to be nicely balanced, but the preponderance must ever be on the side of safety. Guns can be changed when worn out, and their cost, when compared with that of a ship and its crew, is negligible; hence the absolute necessity for cooling apparatus, the insulation of the magazines, effective drowning arrangements, and periodical inspections of the powder.

Nitro-compounds have one great advantage over black powder—they do not explode with nearly the same violence unless very closely confined. Even when, as in the case of the Ferozepore conflagration, the cordite is confined in metal-lined cases, it only burns with great vehemence, and, with effective flooding arrangements, there should be time to prevent disastrous explosions on board ship. At Ferozepore the removal of the black powder, as described above, averted what might have been a terrible disaster. On board battleships the gases evolved by a large conflagration of any nitro-compound would be confined, more or less, by the protective steel deck, bulkheads, and watertight doors, but it is difficult to account for the terrible disruptive effects manifested in the explosion in the ill-fated *Liberté*. It is probable, however, that she had on board her full complement of high explosive (Mélinite) shells. The intense heat of burning cartridges would probably fire one of these, and this would certainly detonate those in the same shell-room. This, of course, is only conjecture, but the curious tearing of steel plates, and the projection of large pieces of heavy armour to great distances, would seem to point to something more in the nature of the detonation of a high explosive than the upheaval that would be caused by the imprisoned gases of a propellant. The inquiry into the cause of the catastrophe will no doubt throw light on this point, but its fatal consequences will tend to make all nations redouble their precautions, not only as regards the storage in battleships, but also in the direction of extreme care in the selection of a propellant which shall not only meet ordinary Service requirements, but on the stability of which they may place absolute trust.

Desmond O'Callaghan.

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